FLUCTUATIONS IN FORAGE QUALITY ON SUMMER RANGE IN THE BLUE MOUNTAINS

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COMMON AND BOTANICAL NAMES OF SPECIES MENTIONED

Trees

Ponderosa pine
Pinus ponderosa Laws.

Douglas-fir
Pseudotsuga menziesii (Mirb.) Franco

Grasses

Bearded bluebunch wheatgrass
Agropyron spicatum (Pursh) Scribn. & Smith

Pinegrass
Calamagrostis rubescens Buckl.

Onespike danthonia
(onespike oatgrass) *Danthonia unispicata* Munro

Idaho fescue
(bluebunch fescue) *Festuca idahoensis* Elmer.

Sandberg bluegrass
Poa secunda Presl.

Grasslike Plants

Elk sedge
Carex geyeri Boott.

ACKNOWLEDGMENT

The author is indebted to G. D. Pickford and E. H. Reid for initial study records of 1941. Special credit for laboratory analyses goes to Doctors E. W. Tisdale and A. W. Wiese, University of Idaho; Dr. J. G. Haag, Oregon State University; and Ranch Way Feed Mills, Ontario, Oregon.

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INTRODUCTION

Rangelands in the Blue Mountains of eastern Oregon and Washington provide 4 to 5 months of grazing for about 100,000 cattle. They also furnish 3 to 4 months of forage for nearly as many sheep. Big-game census and harvest figures indicate these same ranges carry an estimated 200,000 mule deer and about 65,000 elk for 6 to 8 months. The importance of this forage resource is apparent.

Although these native ranges have been grazed by livestock for over 100 years, little is known about their seasonal forage quality. Information on range plant values is needed to aid managers in getting full benefit from the forage supply through improved systems and seasons of grazing. This knowledge will also help ranchers in deciding when to change grazing practices or to market animals. To the big-game manager, the level of late-season forage quality suggests the condition of deer and elk for winter.

This paper combines unpublished research with several reported studies in an attempt to assess overall range forage value in the Blue Mountains. Much of the work has been done on the Starkey Experimental Forest and Range.[1] It has been a field proving ground for grazing research on forest and related ranges for over 25 years.

[1] *This area, hereafter called the Starkey Range, is a 30,000-acre National Forest cattle allotment, 30 miles southwest of La Grande, Oreg.*

HISTORY AND LITERATURE

Reports of grazing preference on range plants in the Blue Mountains date back to the 1880's when botanist Cusick made extensive field collections of local species (Vasey 1889).[2] The first study of seasonal change in forage quality as related to grazing practices took place in northeastern Oregon in 1907 when Sampson (1914) investigated the life histories of many mountain range plants. Using this work as a basis, he put forth the theory of deferred-rotation grazing (Sampson 1913). The first comprehensive forage quality work was on the Starkey Range in 1941 when Pickford and Reid (1948) found nutrient supplies to be generally adequate throughout that season. Subsequent nutritive study indicated that during dry summers, deficiencies could exist (U.S. Forest Service 1960).

Working on nearby forested foothills range, Walton[3] concluded from two seasons of study that during early grazing in June and July, nutrient deficiencies did not occur. He believed, however, that had his study included the last half of the grazing season, he would have noted deficiencies.

Cattle weight studies on the Starkey Range have reflected wide forage quality differences from year to year as well as changes throughout the grazing season (mid-June to mid-October). Yearly weight differences during the normal dry period, August through mid-September, have varied from a daily gain of one-third of a pound to a daily loss of two-thirds of a pound (U.S. Forest Service 1960, 1962). Although cattle show excellent gains while forage is green, prolonged grazing of cured forage has caused young cows to lose up to 3 pounds per day, and their suckling calves also lose weight (Skovlin 1962).

Although no digestibility studies have established actual value of native species in the Blue Mountains, feeding trials have been conducted in adjacent southeastern Washington. Here, McCall[4] observed that the nutrient qualities of bearded bluebunch wheatgrass[5] and Idaho fescue were almost stable after September and that weathering over winter did not materially lower feeding value. However, he asserted, "The significant fact is that after maturity the content of protein, especially is low. . . ."

Forage quality in range plants is largely indexed by protein content. Quoted from the National Research Council (1950), "Less than 8 percent total crude protein in the dry matter of dry range forage . . . is deficient for all classes of cattle." With the exception of phosphorus, and sometimes calcium, other nutrients are ordinarily adequate on native range. Less than about 0.15 percent phosphorus or calcium is also considered a deficient ration (National Research Council 1958).

Besides chemical content, the proportion of total forage that a species contributes to the animal diet is also important. Seasonal preference and use-pattern studies on the Starkey Range showed that cattle grazed certain

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[2]*Names and dates in parentheses refer to Literature Cited, p. 18.*

[3]*Walton, Richard Lee. The seasonal yield and nutrient content of native forage species in relation to their synecology. 72 pp., illus. 1962. (Unpublished master's thesis on file at Oreg. State Univ., Corvallis, Oreg.)*

[4]*McCall, Ralph. Seasonal variation in the composition, feeding value, and digestibility of certain species of range grasses. 46 pp., illus. 1932. (Unpublished master's thesis on file at Wash. State Univ., Pullman, Wash.)*

[5]*Botanical names for plants mentioned are in accordance with Kelsey and Dayton (1942) and are listed on inside front cover.*

species in the grassland openings during early summer and then again in the fall; during midsummer they preferred plants in the forested areas (Harris 1954; Pickford and Reid 1948; Skovlin[6]). About half of the forage removed came from the nonforested grasslands.

Foregoing studies on nutrient content, weight gain, and palatability have pointed up quality gaps in the summer-long forage supply. Follow-up studies on the Starkey Range in 1962 and 1963, together with unreported data in 1958 and 1941, showed which plants are most nutritious and when the different plant communities should be grazed.

[6]*Skovlin, Jon M. A study of the relative utilization of important forage plants on summer cattle range in the central Blue Mountains. 79 pp., illus. 1959. (Unpublished master's thesis on file at Univ. of Idaho, Moscow, Idaho.)*

STUDY AREA

The Starkey Range is situated in the central Blue Mountains. Topography is characterized by broad, undulating divides and ridges dissected by steep-walled drainages. Relief varies between 3,500- and 5,000-foot elevation. Soils are derived mainly from basalt of Tertiary lavas.

CLIMATE

Weather is dominated by Pacific air-

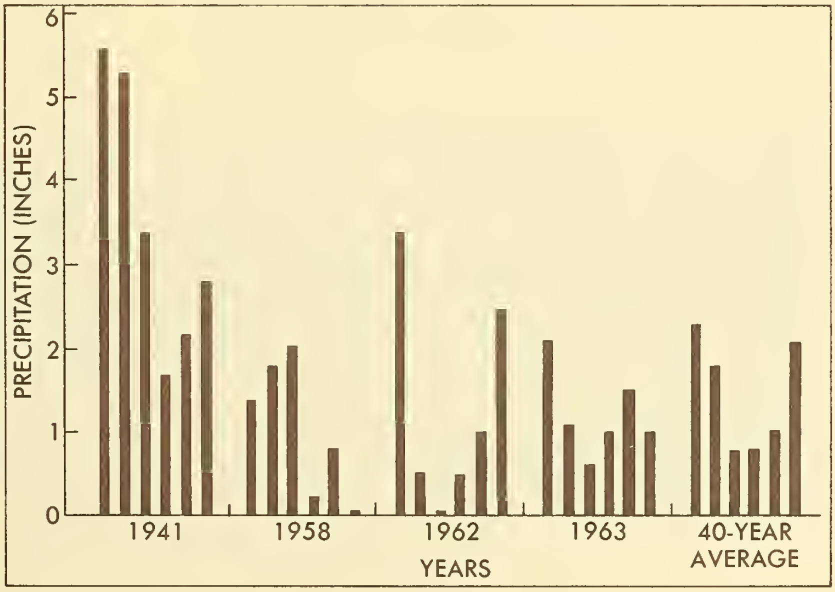


Figure 1. **Monthly precipitation during the years of forage quality investigation, together with the 40-year average. Illustrated are the months of May through October.**

masses. Annual precipitation at the Range headquarters averages 20 inches, nearly half of which falls as snow between November and March. About one-third of the precipitation comes as rain during the spring period of rapid growth which ends late in June. After the dry summer, unpredictable fall rains account for the remaining precipitation. Mean monthly temperatures for summit areas range between 60° Fahrenheit in July to 20° in January. No months are considered frost free above the 4,000-foot elevation.

The growing season averages 120 days, beginning in mid-May and ending about mid-September. Weather during the growing seasons of the 4 years of this report offered a variety of conditions. Average precipitation for this period over a 40-year record was 4.35 inches as compared with that for separate years of this report:[7]

1941,	12.51 inches
1958,	4.86 inches
1962,	1.79 inches
1963,	4.04 inches

The year 1941 set an alltime high for rainfall, whereas 1962 was second to the driest on record. Although 1958 and 1963 were near normal, seasonal distribution varied (fig. 1).

[7]*The headquarters weather station is at 4,100-foot elevation and about 1 mile west of the central study area. The station was moved to its present location from the town of Starkey in 1948. Headquarters is approximately 4 miles west of Starkey; elevation and physiography are about the same.*

VEGETATION

Ponderosa pine, in pure stands and intermixed with Douglas-fir, occupies about two-thirds of the forested area. Grassland openings, ranging in size from about 5 to 50 acres and intermingled with the forested grasslands, form a mosaic pattern (fig. 2).

This coniferous forest range type is characterized by (1) the nonforested Pacific bunchgrass community intermingled with the (2) forested pine-bunchgrass and (3) pinegrass-elk sedge communities. The predominant species of the open grasslands are bearded bluebunch wheatgrass, Sandberg bluegrass, and onespike oatgrass. Under favorable moisture conditions, Idaho fescue is usually codominant with wheatgrass. In the transitional pine-bunchgrass community, wheatgrass and fescue are common, along with elk sedge which is often most abundant. In aggregate, these six species represent over half of the forage removed and about one-fifth of the total herbaceous cover on these ranges.

Plant development can fluctuate widely from year to year, but the relative timing of phenological events among principal species remains constant (fig. 3). For example, elk sedge is always first to develop whereas pinegrass is always last. Wheatgrass and fescue develop at about the same rate, but fescue is invariably first. Although initiation of spring growth varies, the date of seed ripening remains about the same from year to year.

Figure 2. **Grassland openings, intermingled with forested grasslands, make up about one-fourth of the summer range area yet provide nearly half of the forage.**

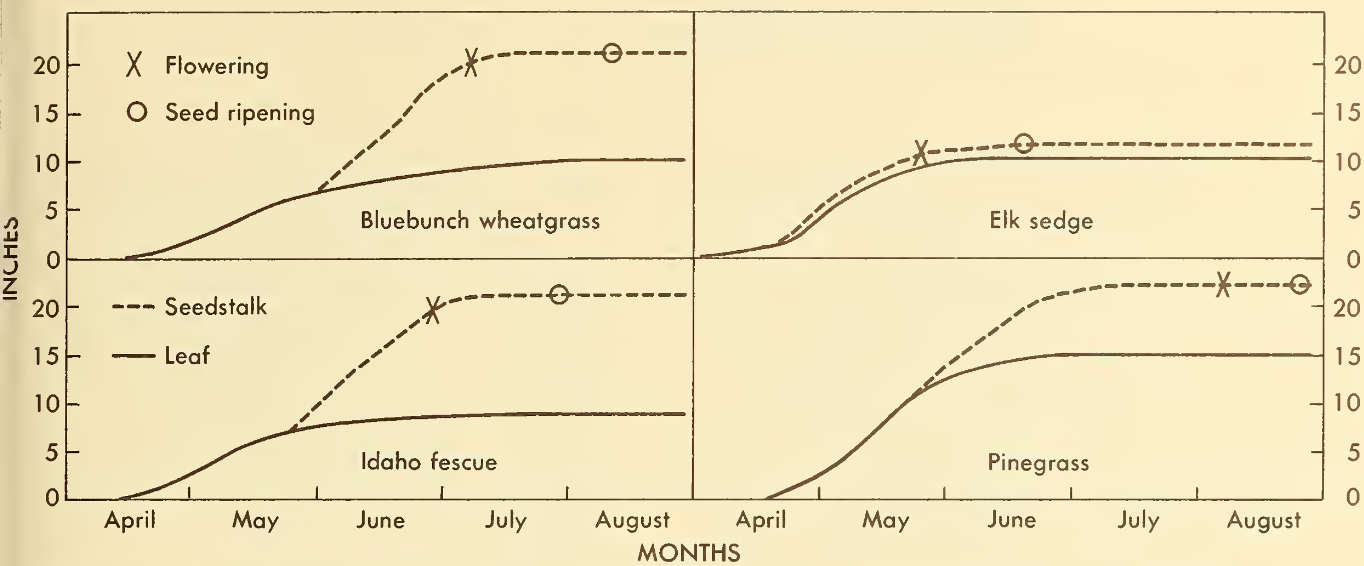


Figure 3. **Normal plant development and height growth of leaves and seedstalks of the four principal forage plants is based on 4 years' data. Average dates of flowering and seed ripening are also shown for the principal species on these middle-elevation ranges.**

PROCEDURE

The scope of this report is limited to sampled plants from two soil types. Grassland openings were predominantly of the Rock Creek very stony loam series, whereas forested range was principally on Underwood silt loam. Plants were periodically collected from the same locality throughout 4 years of study. Although comparisons are presented on a calendar (date) basis, they can be related to phenological stages which are also presented.

A sample constituted fifty to several hundred plants of a species for a particular date. Individual plants were clipped to simulate utilization by cattle, as on a nearby moderately stocked range. Sampling areas were protected from grazing only during the seasons of investigation.

Crude protein was determined in bluebunch wheatgrass, Idaho fescue, elk sedge, and pinegrass throughout the summer and fall each year. Other inorganic compounds, such as fat, fiber, and nitrogen-free extract, were analyzed during certain years. Determinations of phosphorus and calcium were made throughout two seasons. Other components, such as ash, lignin, and carotene, were occasionally compared. Standard methods of analysis were used in determining chemical content. Amounts are expressed as percentages on a dry-matter basis.

Secondary species, including onespike oatgrass and Sandberg bluegrass, were collected on the central study area throughout the 1962 and 1963 seasons. During 1941 and 1958, principal species were collected from two other study locations representing different elevations; also assessed was the difference within a species between range types at the same elevation.

RESULTS

Average crude protein trends of the four principal forage plants in the Blue Mountains are shown as they were determined throughout four grazing seasons (fig. 4).

Protein trends of elk sedge showed the least average seasonal fluctuation by declining from 8 percent in mid-July to 5½ percent in mid-October. Pinegrass, the companion plant in the forest type, displayed the greatest seasonal protein depletion beginning with an average of 8½ percent and falling to less than 3 percent over the same period.

Bluebunch wheatgrass and Idaho fescue of the nontimbered grasslands contained less protein than either forested grassland species until early September. Thereafter, values for wheatgrass and fescue fluctuated between the levels of elk sedge and pinegrass. Wheatgrass and fescue followed patterns that were much alike, except wheatgrass averaged about 1 percent more protein than fescue until late season. After early October, wheatgrass lost rapidly while fescue maintained its protein level. Trends of both species showed a slight increase during early September.

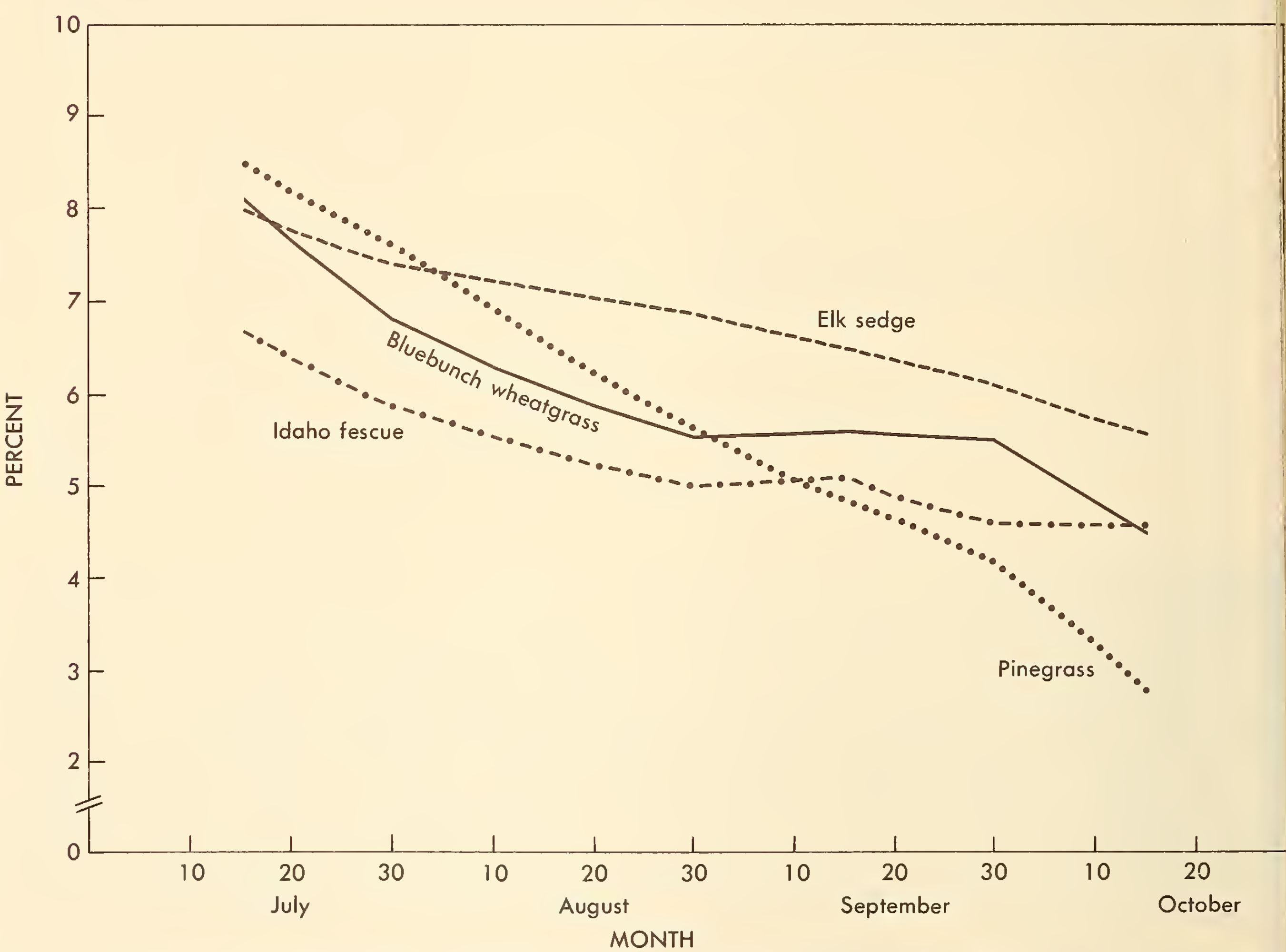


Figure 4. **Trends in crude protein content of important forage plants on Blue Mountain summer range, based on a 4-year average.**

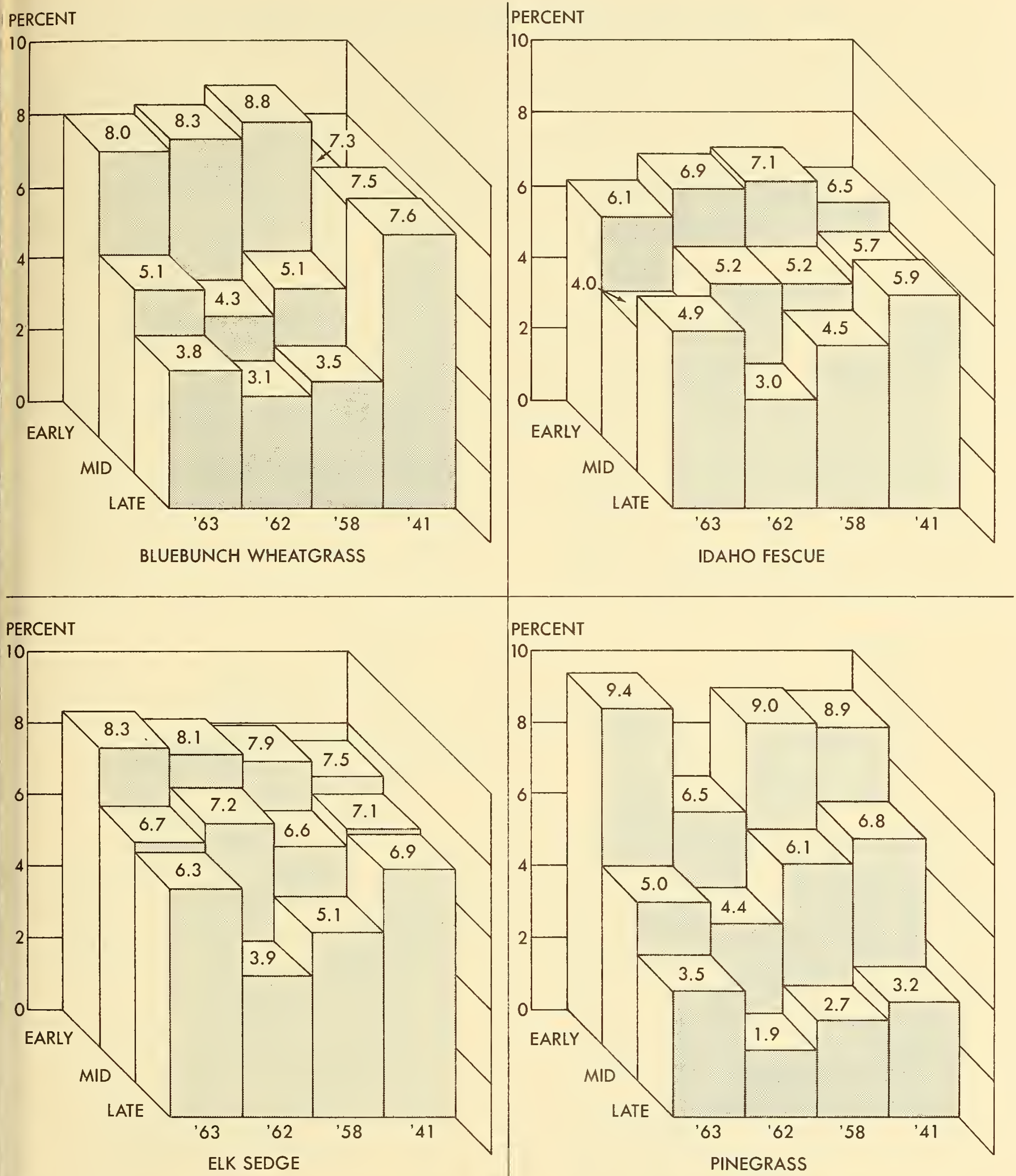


Figure 5. **Percentage of crude protein in major forage plants at three periods during four seasons. Early, mid, and late periods correspond to July 15, August 30, and October 15, respectively.**

Table 1. **Average, standard error, and variability in seasonal crude protein content of the four principal species at three periods throughout the grazing season[1].**

Species	Period								
	Early			Mid			Late		
	Average	Standard error	Variability	Average	Standard error	Variability	Average	Standard error	Variability
	Percent								
Elk sedge	8.0	±0.2	2.5	6.9	±0.1	1.4	5.6	±0.7	12.5
Pinegrass	8.5	± .7	8.2	5.6	± .5	8.9	2.8	± .4	14.4
Bluebunch wheatgrass	8.1	± .3	3.7	5.5	± .7	12.7	4.5	±1.0	23.1
Idaho fescue	6.7	± .2	3.0	5.0	± .4	8.0	4.6	± .6	13.0

[1] *Early, mid, and late periods correspond to July 15, August 30, and October 15, respectively. Average represents 4 years of data.*

Year-by-year fluctuations of protein content illustrate the irregularity in seasonal decline for each species (fig. 5). Elk sedge showed the least yearly variability in protein content, whereas pinegrass showed comparatively large year-to-year differences.

Bluebunch wheatgrass displayed the greatest overall yearly variation, with amounts during 1941 contributing greatly; protein differences for the 3 other years were relatively small. Fescue, though not especially variable, had higher protein content in

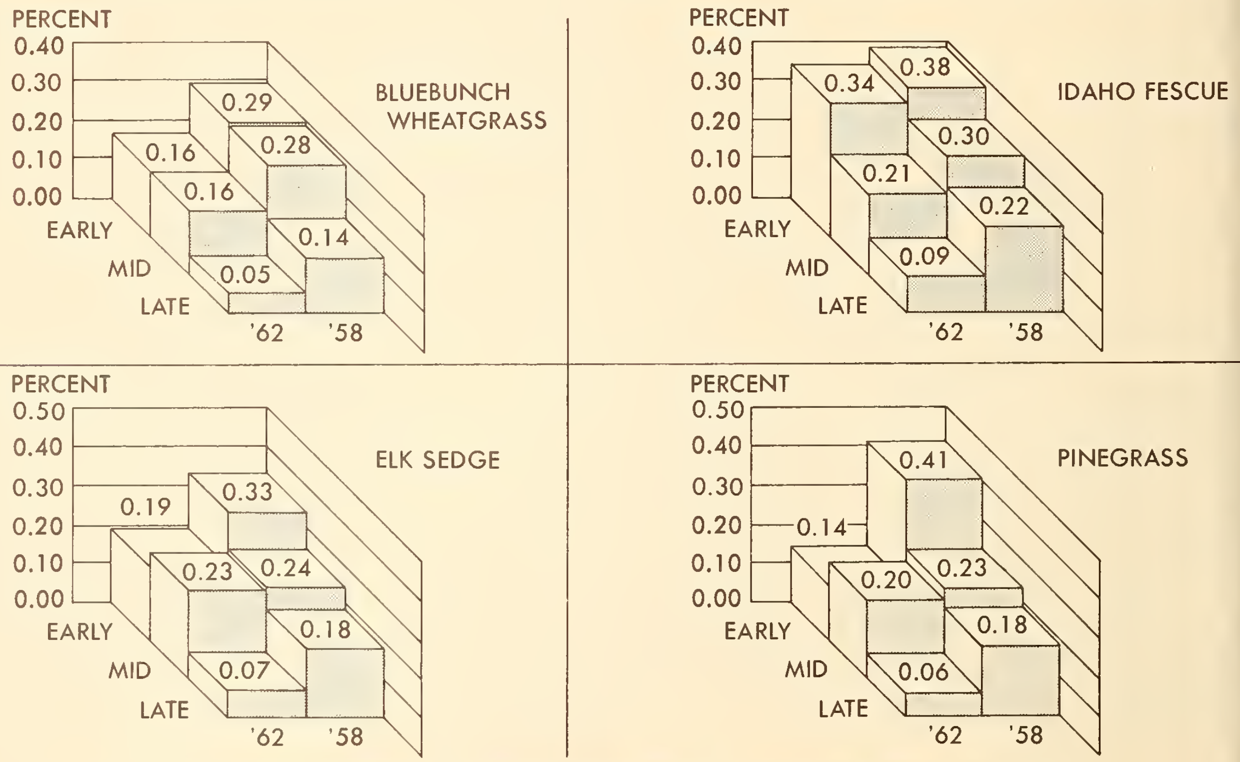


Figure 6. **Percentage of phosphorus in principal forage plants at three periods during 2 years. Early, mid, and late periods correspond to July 15, August 30, and October 15, respectively.**

mid-October than mid-August in two out of the four years.

Yearly deviations in crude protein content were large (table 1). Variability was small during the early period but increased as the season progressed. The exception was elk sedge, which was less variable at midseason than either early or late season. Depending on species, protein variability during late season ranged from two to six times greater than during early season.

In general, protein content of all plants was highest in 1941 and lowest in 1962 with intermediate values in 1958 and 1963. Throughout the mid and late period of 1941, species contained about 25 percent more protein than in 1962.

Phosphorus content was determined in principal species for a 2-year comparison (fig. 6). Relative to protein, phosphorus levels were generally retained further into midseason but fell off more sharply thereafter. As was the case with protein, the forage displayed greater variability in phosphorus content during late season than early season.

Herbage in 1958 contained about twice as much phosphorus as it did in 1962. Moreover, in all 12 seasonal comparisons, phosphorus content was higher in 1958 than in 1962.

The calcium content of several principal plants was determined during 1941 and 1962. Calcium levels fluctuated irregularly in 1941, but in 1962 they declined generally. Quantities ranged between 0.57 and 0.18 percent for these years.

The ratio of calcium to phosphorus varied from a low of 1.5 to 1 to a late-season high of 6 to 1.

DISCUSSION

The general decline of crude protein and phosphorus in forage plants of the Blue Mountains agrees with results reported by workers[8] in other mountain summer ranges. Comparable findings were reported by Stanley and Hodgson (1938) who summarized:

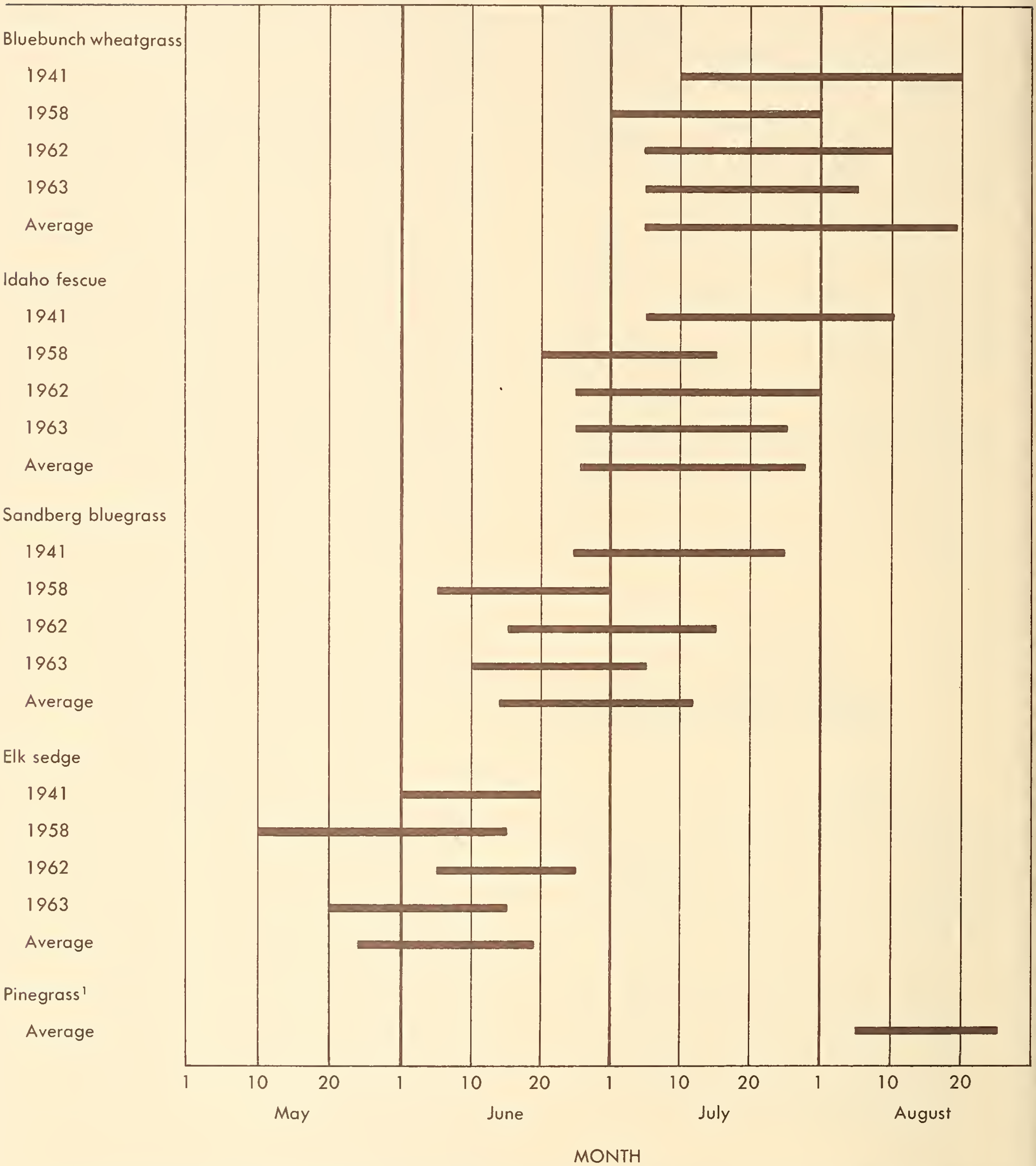
> *A comprehensive review of literature reporting on the chemical analysis of herbaceous plants shows very definitely that crude protein, phosphorous and moisture contents were highest during the early growth stages and that they decreased to a minimum as the plants became mature and dry.*

[8] *Beath and Hamilton (1952); Johnson (1953); McLean and Tisdale (1960); Stoddart and Greaves (1942).*

YEARLY VARIATION IN FORAGE QUALITY

Year-to-year variation in the nutrient content of range plants in other areas has been variously explained by: (1) differences in rate of plant development or reproductive stage (Cook and Harris 1950; Watkins 1940); (2) time lapsed since initiation of growth (Blaisdell et al. 1952); (3) differences in proportion of stems to leaves (Clarke and Tisdale 1945; Heinrichs and Carson 1956); (4) differences in the relative composition of other constituents and their fluctuations by separate plant parts (Fagan and Milton 1931; Green 1934; Pigden 1953); and (5) differences in rate of leaching or oxidation (Guilbert et al. 1931; Hart et al. 1932).

Figure 7. **Inclusive dates from blooming to seed ripening of main forage plants during four growing seasons at middle elevation in the Blue Mountains together with averages.**



[1] *Pinegrass did not produce seedstalks; average was derived from adjacent area.*

Plant development records (fig. 7) and related climatic data (table 2) show that yearly variation in crude protein content of plants in this study were not closely associated with date of reproductive maturity. Nor was content greatly influenced by time lapsed since beginning of growth, assuming that initial growth is largely determined by date of snow disappearance. In other words, these data do not establish that delayed maturity prolonged the retention of protein nor that early growth initiation hastened protein depletion.

However, phasic plant development was related to the accepted rule that high precipitation or low temperatures retard development and low precipitation and high temperatures hasten development (Blaisdell 1958; Costello and Price 1939).

Leaves of forage plants contain more crude protein than seedstalks do, and a change in proportion between years can influence overall herbage protein content. The stem-leaf ratio was not calculated here but probably contributed little to the overall variation in yearly protein fluctuations. This was because most of the sampled species were weak seedstalk producers; pinegrass, for example, never produced seedstalks on the immediate study area. In Idaho fescue, the only plant with significant stem production, simulated grazing avoided stems generally.

Differential leaching has been shown to account for year-to-year changes of mineral constituents and even some organic nutrients. However, other studies have failed to show any real changes in residual protein caused by leaching (Guilbert et al. 1931; McCall 1933; McCreary 1931).

The general loss of herbage protein after maturity has best been explained by the transfer of nitrogen to the roots and stem bases (Murneek 1932). Similarly, cyclic losses and gains in protein content of herbage in bluebunch wheatgrass have been shown to accompany opposite trends of protein levels in roots (McIlvanie 1942). What is not known is how weather influences this rate of protein change.

Table 2. **Growing-season characteristics at midelevation in the Blue Mountains during 4 years of investigation.**

Month	Year 1941	1958	1962	1963
	Precipitation (percent of 40-year average)			
April	77	51	74	137
May	218	51	131	78
June	322	112	30	64
July	388	350	5	109
August	232	27	73	137
September	253	93	112	171
October	138	1	120	46
	Temperature deviation (degrees F. from average)			
April	−0.6	−2.4	+2.4	+3.3
May	+2.5	+6.5	−5.6	+1.9
June	+2.0	+3.6	− .4	0
July	+2.3	+3.7	− .6	−4.8
August	+ .7	+5.1	−3.0	+1.3
September	−3.1	−1.2	+1.5	+6.4
October	− .6	+5.2	0	+1.8
	Snowmelt (remaining depth in inches)			
April	0	17	19	0
May	0	2	0	0
June	0	0	0	0

In this mountainous region of shallow soils, effective precipitation appeared to be the main factor determining crude protein content of herbage. High precipitation was accompanied by excellent protein retention in 1941. On the other hand, severe drought conditions of 1962 were associated with extremely low protein levels. The summers of 1958 and 1963 were near normal in both precipitation and herbage protein content. Logically, if soil-moisture deficit influences summer plant dormancy, then greater precipitation, enabling continued metabolism and photosynthesis, would require nitrogen maintenance.

SEASONAL VARIATION IN FORAGE QUALITY

An inspection of the two more normal seasons shows considerable difference in their rainfall distribution (fig. 8). In 1963, the ordinary pattern was a gradual decrease in precipitation into midsummer followed by a gradual increase. However, in 1958, precipitation increased through July, and the onset of drought came abruptly in August; fall moisture was below normal.

Crude protein depletion throughout 1963 was gradual, and by fall, wheatgrass and fescue even increased their content slightly (fig. 9). However, in 1958, midsummer protein trends reflected the abrupt drought as well as the below average fall rains. In all species, fall protein levels in 1958 were below those of 1963.

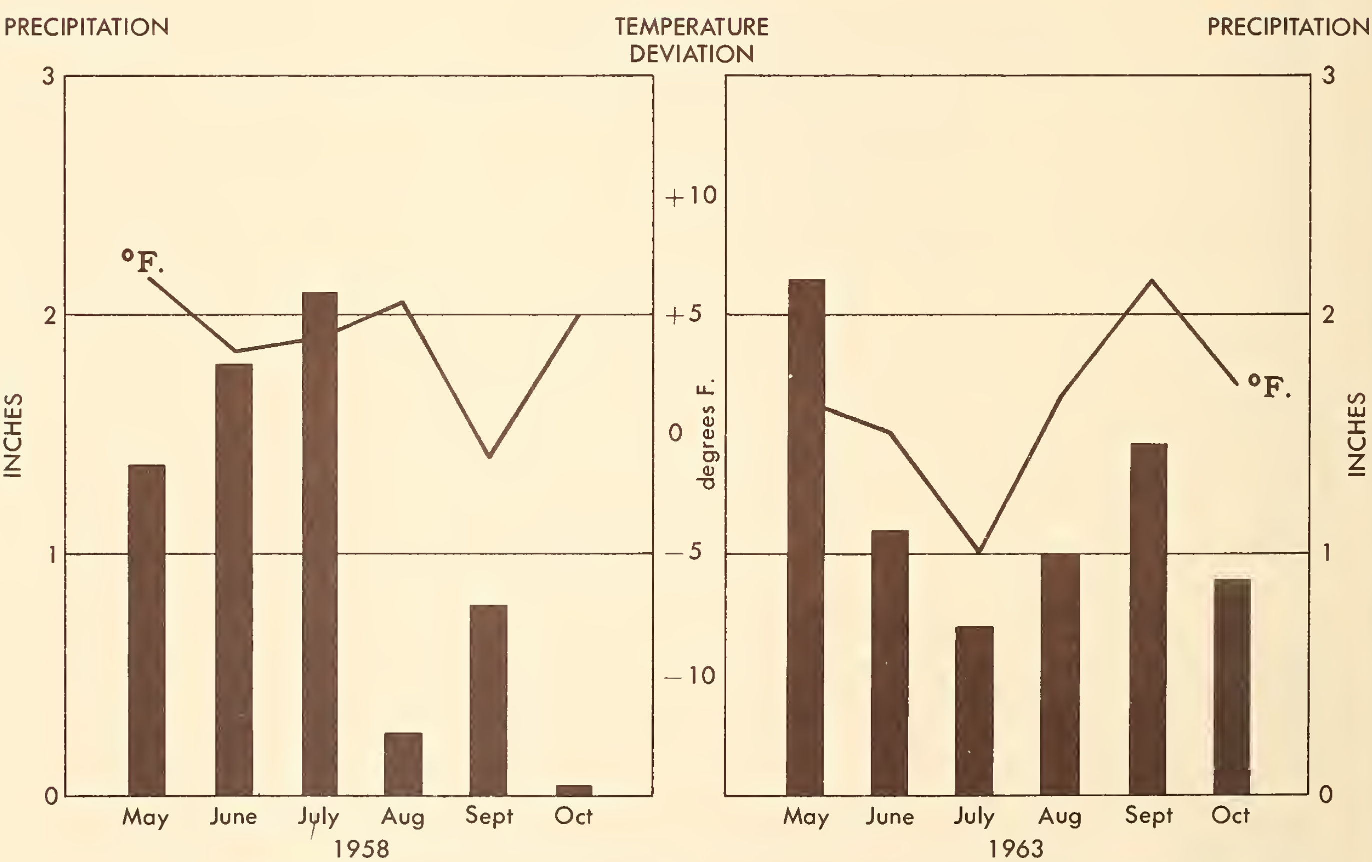


Figure 8. **A comparison of precipitation and temperature deviation during the 2 years of near-normal forage conditions.**

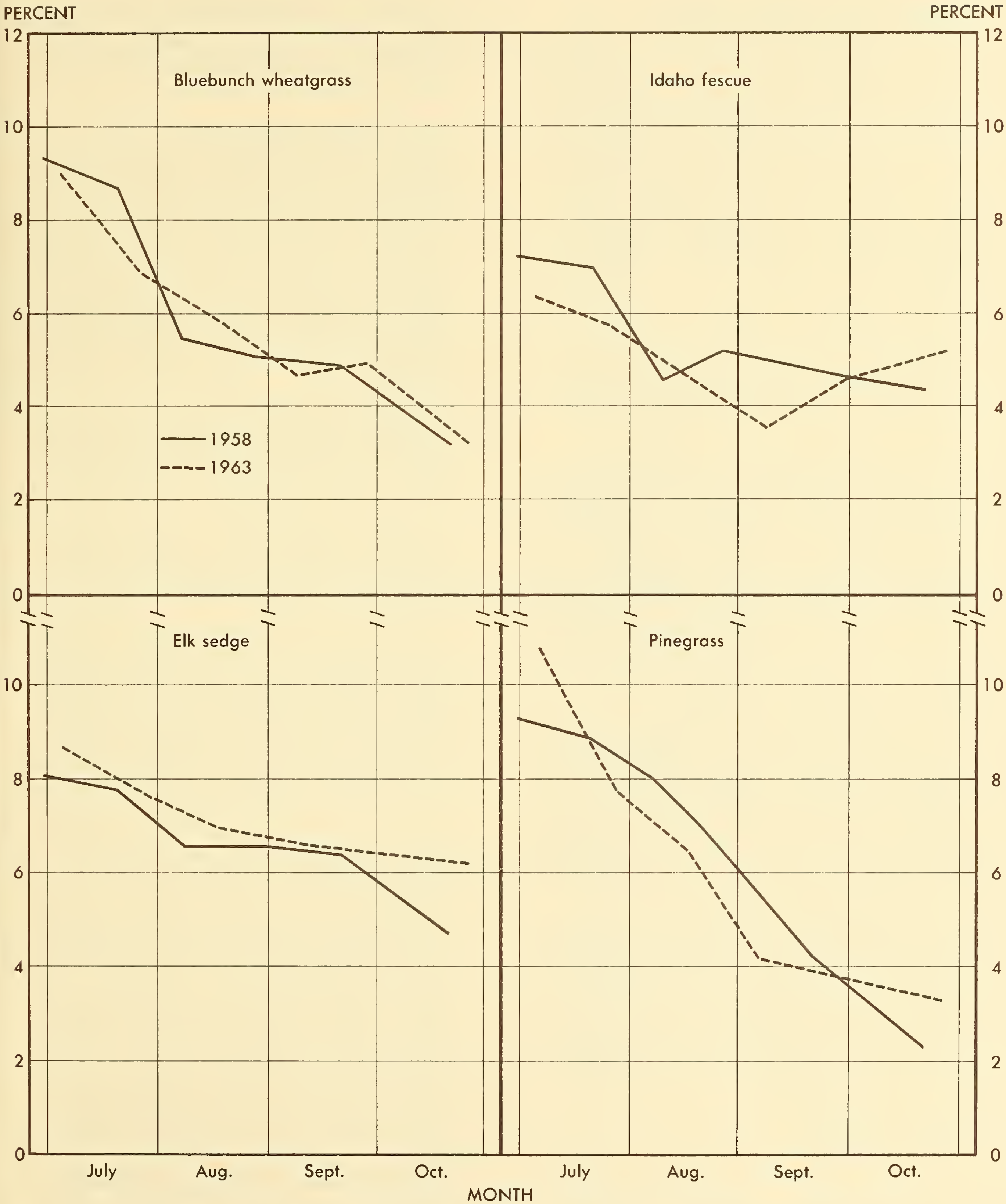


Figure 9. **Crude protein trends of important forage plants during the two near-normal growing seasons.**

LATE-SEASON FORAGE QUALITY

Fall crude protein levels were most closely related to decreasing amounts of rainfall during all 4 years of study. With one exception, all four species were highest in 1941, next highest in 1963, next to the lowest in 1958, and lowest in 1962; this order of protein content corresponded directly with amounts of effective fall precipitation. The exception was pinegrass which contained slightly more protein in 1963 than in 1941.

All bunch-forming grasses in the grassland openings produced regrowth after the first substantial rains in the fall. The shallow-rooted onespike oatgrass and Sandberg bluegrass were especially responsive.

During summer, soil moisture is being depleted as the plants mature. By fall, the amount of moisture entering the parched soil determines the extent of regrowth in the standing crop and, consequently, the quality of late-season forage. However, rains must come early enough so that temperatures will still be warm enough to promote a vigorous regrowth. By late October, temperatures may not get high enough to promote good regrowth conditions.

In 1941 and 1963, most open grassland species produced enough regrowth to increase fall protein levels above midsummer lows. However, in 1958 fall rains were not sufficient to promote adequate regrowth, and in 1962 rains were too late to measurably improve the forage supply.

In the forest communities, tree overstory tends to modify climate near the ground, producing different moisture conditions. Here, neither elk sedge nor pinegrass produced regrowth during the years of study. However, fall rains did serve to arrest their rate of protein depletion in proportion to the amounts received.

PLANT VALUES

Illustrated results show that each species displayed independent and somewhat different overall seasonal nutrient trends. This information plus results from similar work will be compared with minimum daily requirements to arrive at generalized forage quality characteristics.

Elk sedge. — From the standpoint of sustained nutrient supply, elk sedge outranked all other plants investigated. Sedge maintained an adequate level of crude protein nearly a month longer than other species. Yearly comparison of protein trends showed elk sedge to be the species least affected by growing-season variation. It also showed less within-season fluctuation compared with other species. When sampled, calcium and phosphorus content in elk sedge rated fair to good.

Sampson (1917) reported elk sedge to be very drought resistant, and others (Driscoll 1957; U. S. Forest Service 1937) have indicated it withstands grazing well. Since herbage remains semievergreen for several years, elk sedge is relished by all classes of livestock and big game, especially after midsummer when other forage has cured.

The excellent grazing qualities of elk sedge can be attributed to its unique growth habits. Vegetative shoots, produced from semiwoody rootstalks during the first year's growing season, do not emerge as herbage until the following year and remain green for 2 or more years. Thus, vernal development is not supported entirely by stored food reserves, and this permits early development seemingly independent of prevailing spring weather.

Pinegrass. — In contrast to elk sedge, pinegrass generally contained a rich supply of nutrients during early season but was practically worthless as forage late in the season. After midseason, crude protein in pinegrass declined sharply, and by season end, it was consistently lower than in all other species. Pinegrass showed large year-to-year variation as well as the largest within-season decline. Phosphorus values were rather poor during one year but good in the other. Morphology and growth characteristics suggest this plant might be subject to leaching or oxidation which may ac-

count for extreme late-season losses of quality. General fall regrowth of pinegrass has not been observed on summer range in the Blue Mountains.

Nutrient trends in pinegrass were comparable to those reported by McLean and Tisdale (1960) from interior British Columbia summer range. They found crude protein content to average 8.3 percent in mid-July and 2.7 percent in early October, and phosphorus for these periods was 0.25 to 0.12 percent, respectively. From studies in the Rocky Mountains of Alberta, Clarke and Tisdale (1945) showed that by mid-August pinegrass content averaged 5.5 percent protein and 0.16 percent phosphorus, which is somewhat lower than the average for the same period reported here. Apparently, pinegrass is poor-quality, late-season forage throughout much of its distribution.

The grazing value of pinegrass has been described in a comprehensive report (U. S. Forest Service 1937) which stated, "Much diversity of opinion exists regarding the forage value of pinegrass due, no doubt in large part, to its varying palatability at different times of the year." Though it is rated fair to good in the Blue Mountains, palatability here declines rapidly with the season's advance. Although pinegrass grows in a spreading mat, shallow rootstalks of new plants are easily pulled up during early-season grazing.

Bearded bluebunch wheatgrass. — During the grouped years, wheatgrass contained very high, early-season, crude protein content; but, from blooming until seed was ripe, it had the most rapid decline of any species. As midseason forage, wheatgrass rated moderately good in quality, except in 1941 when it was excellent. After early October, however, protein in wheatgrass showed a marked general depression. Wheatgrass had low phosphorus content throughout all seasons and especially from maturity onward. Low amounts of phosphorus with relatively high calcium quantities accounted for a wide calcium-phosphorus ratio in wheatgrass from midseason on.

Many reports[9] contain seasonal nutrient trends of bluebunch wheatgrass, and some even show the seasonal trends as affected by clipping (McIlvanie 1942; Stoddart 1946). The preponderance of literature on nutrient quality of wheatgrass agrees closely with this report of the overall seasonal values for crude protein, calcium, and phosphorus.

Bluebunch wheatgrass is readily grazed by all classes of livestock throughout the year. Due to high palatability and general abundance, it is recognized as the most important native grass throughout the inland Pacific Northwest. Although wheatgrass of the Blue Mountains is no exception, in the coniferous forest range type elk sedge merits at least equal rank.

Idaho fescue. — Although fescue contained low amounts of protein throughout the first half of the season, it tended to stabilize or even increase its content during late season. Thus, fescue generally ended the season with relatively high quantities. Fescue was consistently high in phosphorus and contained ample supplies of calcium throughout the periods studied.

In the Laramie Mountains of Wyoming, Beath and Hamilton (1952) learned that fescue contained lower early-season quantities of protein than bluebunch wheatgrass but higher late-season amounts. The relationship was found to be true in this study and especially so on a year-by-year comparison.

In a 4-year study of Idaho fescue in southeastern Washington, McCall (1939) reported little fluctuation in the protein content of fescue from late summer until the following spring. In an earlier report (1933), he found the total digestible nutrients to be generally higher in mature fescue than in mature wheatgrass. Workers in other areas (Clarke and Tisdale 1945; Robertson and Torell 1958) also found fescue contained high nutrient value compared with other species with which it was associated.

[9] *Beath and Hamilton (1952); Blaisdell et al. (1952); McCall (1933); Robertson and Torell (1958).*

The palatability of fescue is generally high for all classes of stock, an exception being in mountainous areas in central Oregon and isolated localities of the southern Blue Mountains (Reid 1942). Generally, fescue is preferred over wheatgrass when the two are presented in near equal amounts, particularly during late-season grazing (Skovlin 1961). The choice of fescue over wheatgrass has also been demonstrated in feeding trials of these grasses in the cured state (McCall 1933).

Associated species. — In the Blue Mountains, Sandberg bluegrass and onespike oatgrass are secondary forage plants found in grassland openings. They are important because either may predominate on some sites, and both are present on most sites.

Sandberg bluegrass contained the lowest early-season protein content of all species; its phosphorus quantities were also generally lowest. Protein during July and August averaged about 4 percent, and phosphorus was about 0.15 percent. In favorable years, however, protein in bluegrass responded to fall rains almost immediately — nearly 2 weeks before increases appeared in wheatgrass or fescue. Phosphorus, on the other hand, showed no significant fall response.

Comparing the value of Sandberg bluegrass with its associated species, Beath and Hamilton (1952) showed bluebunch wheatgrass and Idaho fescue had nearly twice the protein content of bluegrass throughout the season. However, the phosphorus content in bluegrass was only slightly below that of wheatgrass or fescue. Robertson and Torell (1958) reported generally higher nutrient values for Sandberg bluegrass on high-elevation, sage-grass ranges in Nevada than were found here. Other studies[10] have reported Sandberg bluegrass to be fair in nutrient quality at maturity but then to fail rapidly compared with the principal grasses it is associated with.

Because of early development, Sandberg bluegrass is one of the first plants ready for spring grazing and usually furnishes some forage, depending on the abundance and development of other species. Though it becomes dormant after mid-July, in the Blue Mountains it is the first perennial grass to green up in response to fall rains. With abundant fall moisture, it regenerates high-level nutrient content, and under these conditions bluegrass is grazed avidly.

The nutrient qualities of onespike oatgrass compared closest with those of bluebunch wheatgrass. Contrasted with Sandberg bluegrass, oatgrass was far superior. During July and August, oatgrass averaged about 2 percent more protein and 0.05 percent more phosphorus than Sandberg bluegrass. Like bluegrass, oatgrass responds rapidly to favorable fall rains.

Since oatgrass occupies sites not suitable to wheatgrass and has better nutrient qualities than Sandberg bluegrass, it is the most valuable forage on harsh scablands. Though well adapted to heavy shallow soils, oatgrass is plagued by other adversities of this environment. Its swollen and succulent stem bases are attractive to rodents, mainly pocket gophers. Because soil on these poorly drained sites becomes quickly saturated, oatgrass is frequently damaged by frost heaving, especially during late fall. It is also winter-killed on exposed sites in severe weather.

Since onespike oatgrass and Sandberg bluegrass are subject to wide fluctuations in forage production and nutrient quality, they are not dependable summer forage. However, they may contribute the only adequate fall grazing in some years.

[10] *Beetle (1960); Blaisdell et al. (1952); Clarke and Tisdale (1945); McLean and Tisdale (1960).*

SUMMARY

Trends in nutrient content of principal forage plants on the Blue Mountains summer range were investigated during four growing seasons. Weather patterns here produce a forage supply which is characterized by an adequate green season, an inadequate dry season of a month or more, and a late season which may or may not be adequate.

Forage quality decline was similar to that reported for the same species in other mountainous regions. There were no striking deficiencies except for generally low protein content during late summer and fall. In one of the 4 years investigated, continued drought produced low-quality forage that was entirely inadequate throughout the entire last half of the grazing season.

Year-to-year variation in forage quality was interpreted in light of plant development, dates of phenological events, curing conditions, and secondary fall growth as influenced by precipitation, temperature, and time of regrowth. Except for amount of rainfall after blooming time, no single factor was consistently related to crude protein content during these years. Some species, like elk sedge, showed little yearly or within-season variation, but others, such as pinegrass, varied greatly.

Seasonal variability in nutrient content was found to be much greater during late season than during early season. Also, plants common to open grasslands produced regrowth in response to effective fall rains, whereas those of the forested types did not. It was significant, however, that elk sedge in the forest maintained good quality throughout, from early to late season.

Plant values, as determined by chemical content, seasonal preference, and relative abundance, were compared and discussed. Some species were better forage than others at certain times; however, each plant contributed to overall nutrient balance by virtue of complementary seasonal value. Generally, species low in nutrient quality during early grazing season contained high late-season levels, and those high during early season had low late-season levels. Animal preference usually followed these shifts in seasonal quality.

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